Basal Melt Beneath Ice Stream A and Whillans Ice Stream (B)

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A recent comparison of velocity determined from RADARSAT data with velocity measurements collected from the mid 1970's to mid 1980's confirms earlier estimates of deceleration and suggests that deceleration is widespread over Ice Stream A and Whillans Ice Stream (B). Here we examine the role of till strength and basal melt in this deceleration. Under reasonable assumptions, local conditions beneath the ice plain suggest basal freezing and a trend toward shutdown. As suggested by other authors, import of water from upstream may be necessary to sustain motion under conditions of local basal freezing. We have estimated the melt/freeze rate beneath Ice Stream A and Whillans Ice Stream and their tributaries. We used measured velocity and basal drag derived from force balance calculations to estimate basal shear heating. We model temperature with a simple vertical advection-diffusion equation, "tuned" to match temperature profiles from boreholes at the UpB camp. Geothermal flux was set to be 0.07 w/m^2 [Engelhardt, pers. comm.]. With these constraints, the estimated average melt rate beneath the ice streams and their tributaries is 2.4 mm/yr. Most of the melt is generated beneath the tributaries where basal shear stress is larger and the temperature gradient favors greater melt (e.g., 10-20 mm/yr). Basal freezing occurs beneath much of the ice plain. The temperate profile at UpB constrains only about one third of the flux entering the ice plain. If we estimate temperature using parameters that are similar to the catchments of Ice Streams C and D, then we obtain a net freezon rate of 0.7 mm/yr.Within the sensitivity of the model net freezing or melting may take place, with a slight bias toward surplus melt.

Topics Ice Streams (3) and Basal boundary conditions (4).